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Development and modeling of the weighting algorithm of the passenger vehicle transportation quality

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Abstract. At the moment, the role of passenger vehicles (PV) in human life is quite large. People use PV almost every day. Recently, however, the roads are becoming more overloaded due to the increase in the number of vehicles. Consequently, the likelihood increases of less quality transportation. And the indicator of the quality of transportation is key in its assessment. One way to solve this problem is to develop an application that allows users to provide better information on how to get to their destination. However, for such an application to work, it is necessary to develop an algorithm by which it will work. This article proposes a weighting algorithm for assessing the quality of transportation of passenger vehicles. This algorithm works according to the following principle: the destination enters; the user assigns weight values to the characteristics of transportation (for example, convenience, safety, etc.); there is a comparative characteristic of vehicles going to the destination for each of the criteria (places are assigned for each of the criteria); at the end, the rating of each vehicle is compiled on the basis of multiplying the weight values of the vehicle seat by the criterion and the weight coefficient of the transportation criterion and further summing up the resulting terms.

1. Introduction

The usage of passenger vehicles (PM) to move people from one point of the city to another is quite popular. Due to the fact that the number of transport is growing every year, routes followed by PM are becoming more overloaded. And one of the main human needs is fast and high-quality transportation to the desired point of the city. In order for a person to know how to get to a destination in the best way, it is necessary to develop an application that will provide routes in a ranked order (from best to worst). However, for such an application to work, it is necessary to develop an algorithm by which it will work. The purpose of this article is to develop an algorithm of the passenger vehicles transportation quality, which allows you to get routes in a ranked order (from best to worst) depending on the user's requirements [1,2]. After that, a model of the application will be offered that works on the basis of the proposed algorithm.

2. Description of the passenger vehicles transportation quality algorithm

Let the source route has the following quality criteria [3]:

- percentage of vehicle occupancy (convenience) (the lower the percentage, the more convenient the vehicle is considered);



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- transportation time to the destination (the less time spent by the vehicle, the better the transport);
- frequency of occurrence of a specific PV (the shorter the time between arrivals of the same route to the stop, the better the transport);
- safety (the more time a vehicle spends, the safer it is considered to move) [4].

To influence the above criteria on the choice of a particular route vehicle, it is necessary to develop an algorithm that consists in assigning weight values to each of the transport properties. Let's call this method a weighting algorithm for optimizing PV routes. The key influence of a particular indicator on the selected vehicle should be determined by the user of the application running on the algorithm described above. Let the impact of each criterion be evaluated using a 10-point system. In the developed application, the user will be asked to evaluate the importance of a particular indicator of the quality of transportation. Depending on the values assigned by the user to a specific transportation criterion, they are assigned specific weight values.

The block diagram of the Weighting algorithm for the route optimization of the PV is shown in Figure 1.

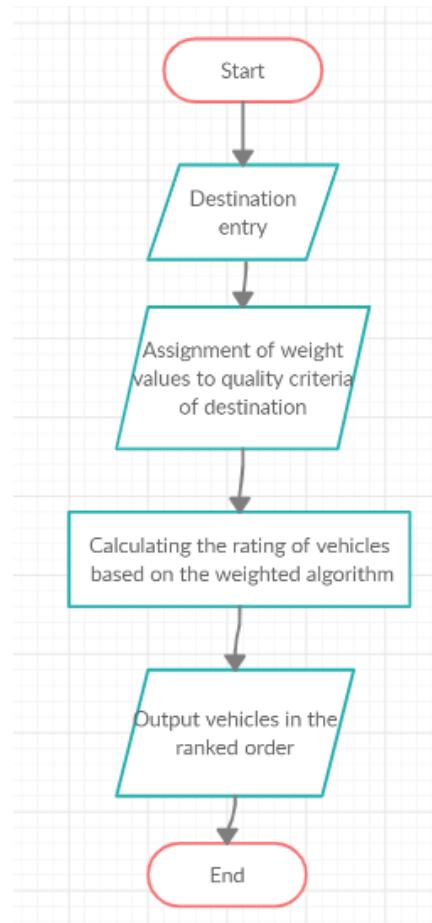


Figure 1. Block diagram of the weight algorithm

For example, a passenger assigned the following values to the criteria: percentage of occupancy = 10, travel time = 7, frequency of appearance = 8, safety = 10. Then each of the quality indicators is assigned the following weight coefficients. Each of the user-assigned values is a weighting factor.

The higher the weight value of the criterion, the more influence it has on the choice of vehicle for transportation.

Let's assume that there are three route vehicles that go to the destination specified by the passenger. PV have the following indicators:

- vehicle №1: percentage of occupancy = 50%, transportation time = 15 minutes, frequency of occurrence = 20 minutes, safety = 0.7;
- vehicle №2: percentage of occupancy = 40%, transportation time = 20 minutes, frequency of occurrence = 25 minutes, safety = 0.9;
- vehicle №3: percentage of occupancy = 70%, transportation time = 12 minutes, frequency of occurrence = 15 minutes, safety = 0.5.

Look at Table 1 in which we indicate the location of the PV for a particular indicator.

Table 1. Places of vehicles by transport quality indicators.

PV Indicator	Percentage of occupancy	Transportation time	Frequency	Safety
1	2	2	2	2
2	1	3	3	1
3	3	1	1	3

Enter a formula for calculating the vehicle rating [5]:

$$R = WF_{PO} * P_{PO} + WF_{TT} * P_{TT} + WF_F * P_F + WF_S * P_S \quad (1)$$

where WF_{PO} – weighting factor percent occupancy, P_{PO} – place of the vehicle on the percentage of occupancy, WF_{TT} – weight ratio time of shipment, P_{TT} – the place of the vehicle at the time of transportation, WF_F – weighting factor of frequency of appearance, P_F – place of the vehicle on the frequency of occurrence, WF_S – weighting factor of safety, P_S – place of the vehicle on security. Calculate the rating of each vehicle in accordance with the formula (1).

$$R_1 = 10 * 2 + 7 * 2 + 8 * 2 + 10 * 2 = 70 - \text{PV rating } \text{№}1;$$

$$R_2 = 10 * 3 + 7 * 1 + 8 * 1 + 10 * 3 = 75 - \text{PV rating } \text{№}2;$$

$$R_3 = 10 * 1 + 7 * 3 + 8 * 3 + 10 * 1 = 65 - \text{PV rating } \text{№}3.$$

Ranking of vehicles by their rating (the higher the rating, the higher the place of the vehicle):

1. PV №2.
2. PV №1.
3. PV №3.

3. Development of application model

The application interface for the weighting is shown in Figure 2.

The result of the application is shown in Fig. 2.

High-quality transportation

Enter the destination:

Evaluate the importance indicators using a 10-point scale:

Convenience

Transportation time

Arrival frequency

Safety

№ PV name Arrival Frequency

1 PV № 82 Every 10 minutes

2 PV № 27 Every 15 minutes

3 PV № 25 Every 20 minutes

Figure 2. Application result.

Information about the vehicles that follow to the destination is stored in a dictionary the key of which is the entered street, and the value is an array containing vehicle numbers [6]. The storage of information about vehicles using a dictionary is shown in Figure 3.

```
streetNamesAndTransportNumbersDictionary["Komsomolskaya"] = new int[] { 25, 27, 82};
streetNamesAndTransportNumbersDictionary["Mira"] = new int[] { 18, 54, 70 };
streetNamesAndTransportNumbersDictionary["Malysheva"] = new int[] { 19, 50, 77 };
```

Figure 3. Storage of information about vehicles.

To store the information about the indicators of route vehicles, a dictionary is also used the key of which is the vehicle number, and the index is a dictionary with the key which is the vehicle indicator, and the value, which is the value of the indicator [7]. The storage of information about the indicators of route vehicles using a dictionary is shown in Figure 4.

```

transportInformationDictionary[25] = new Dictionary<string, int>();
transportInformationDictionary[25]["PV number"] = 25;
transportInformationDictionary[25]["Fullness percentage"] = 30;
transportInformationDictionary[25]["Transportation time"] = 20;
transportInformationDictionary[25]["Arrival frequency"] = 20;
transportInformationDictionary[25]["Safety"] = 80;
transportInformationDictionary[27] = new Dictionary<string, int>();
transportInformationDictionary[27]["PV number"] = 27;
transportInformationDictionary[27]["Fullness percentage"] = 40;
transportInformationDictionary[27]["Transportation time"] = 15;
transportInformationDictionary[27]["Arrival frequency"] = 15;
transportInformationDictionary[27]["Safety"] = 75;
transportInformationDictionary[82] = new Dictionary<string, int>();
transportInformationDictionary[82]["PV number"] = 82;
transportInformationDictionary[82]["Fullness percentage"] = 90;
transportInformationDictionary[82]["Transportation time"] = 10;
transportInformationDictionary[82]["Arrival frequency"] = 10;
transportInformationDictionary[82]["Safety"] = 50;

```

Figure 4. Storing information about the performance of each of the vehicles.

4. Checking the correctness of the application model

To store the information about the indicators of route vehicles, a dictionary is also used the key of which is the vehicle number.

Using Figures 2-4, we will compile a summary table of the indexes of each of the indicators for passenger vehicles traveling to the destination specified by the user. For the analysis, only those vehicles were selected that go along Komsomolskaya Street (PV with numbers 25, 27 and 82).

PV characteristics:

- PV №25: percentage of occupancy = 30%, transportation time = 20 minutes, frequency of occurrence = 20 minutes, safety = 80%;
- PV №27: percentage of fullness = 40%, transportation time = 15 minutes, frequency of occurrence = 15 minutes, safety = 75%;
- PV №82: percentage of fullness = 90%, transportation time = 10 minutes, frequency of occurrence = 10 minutes, safety = 50%.

Table 2 shows the places of vehicles according to the corresponding indicators of the quality of transportation.

Table 2. Places of vehicles according to the quality of transportation.

PV indicator	Percentage of occupancy	Transportation time	Frequency	Safety
25	1	3	3	1
27	2	2	2	2
82	3	1	1	3

Let's calculate the rating of each vehicle in accordance with the proposed algorithm using formula (1).

$$P_{25} = 7 * 3 + 10 * 1 + 6 * 1 + 8 * 3 = 61 - \text{PV rating \# 25};$$

$$P_{27} = 7 * 2 + 10 * 2 + 6 * 2 + 8 * 2 = 62 - \text{PV rating \# 27};$$

$$P_{82} = 7 * 1 + 10 * 3 + 6 * 3 + 8 * 1 = 63 - \text{PV rating \# 82}.$$

Ranking PV by their rating:

1. PV № 82.

2. PV № 27.

3. PV № 25.

As you can see, from the calculations obtained, the result of the work shown in Figure 2 is correct.

5. Conclusion

This article proposes the algorithm for assessing the quality of transportation of passenger vehicles. Its idea is to assign weighting factors to the transportation criteria depending on the user's request. For this algorithm, a formula for calculating the rating of passenger vehicles is proposed. The formula includes the weights of the transportation indicators assigned by the user, as well as the weight of the place of this or that indicator. For this algorithm, an application model is proposed. The application interface is presented as well as the output of passenger vehicles depending on the entered data. The correctness of the displayed information has been checked.

6. Acknowledgments

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